Insect trends, uncertainty and risk-of-bias

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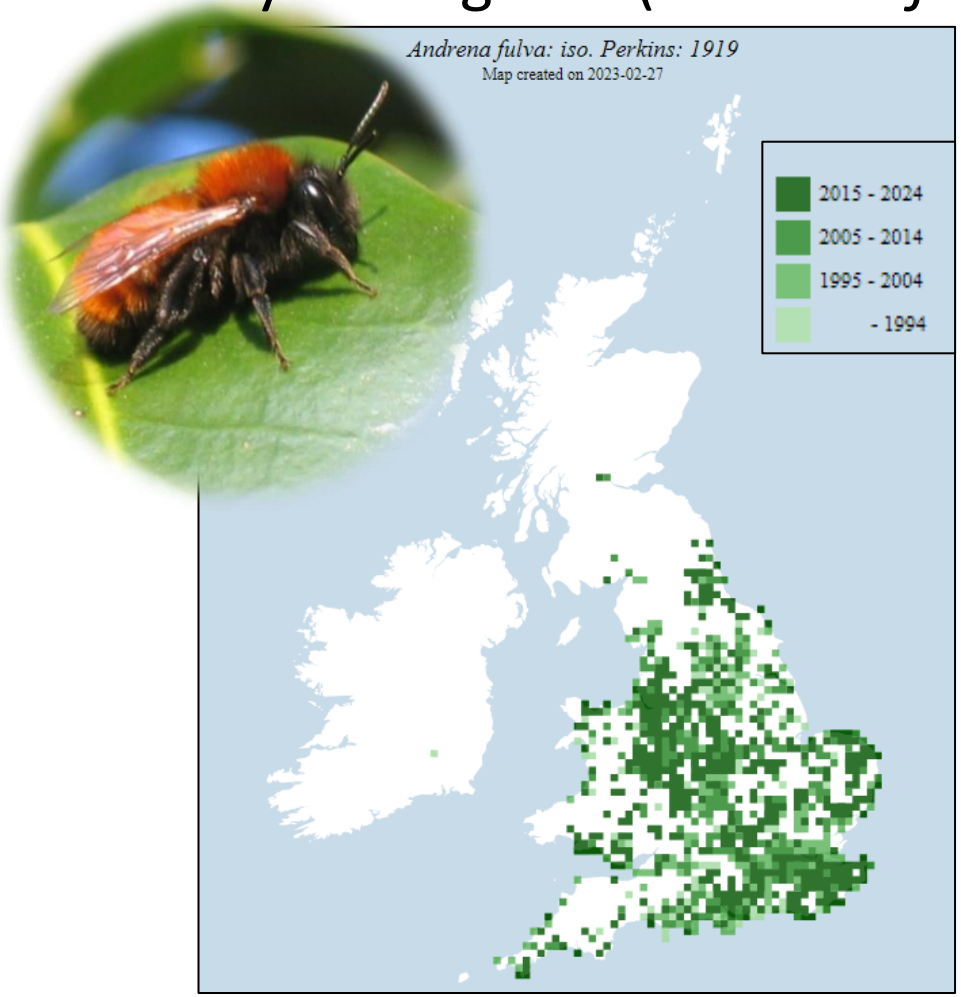
Background

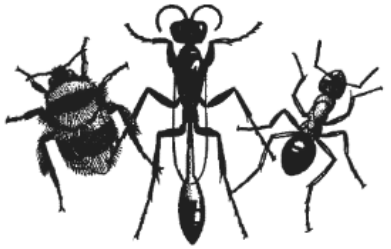
- **Aim**: present new occupancy trends but in context of data driven risk-of-bias assessments and taxonomic expert feedback
- Data + Occupancy model summary (Note: same method used for UK Govt. indicators, State of Nature, range of papers)
- Overview: Risk-of-bias assessments and expert feedback steps
- Results: 1) Bias assessment, 2) Expert feedback. No trends today!

Data source – Biological records

Tawny mining-bee (*Andrena fulva*)



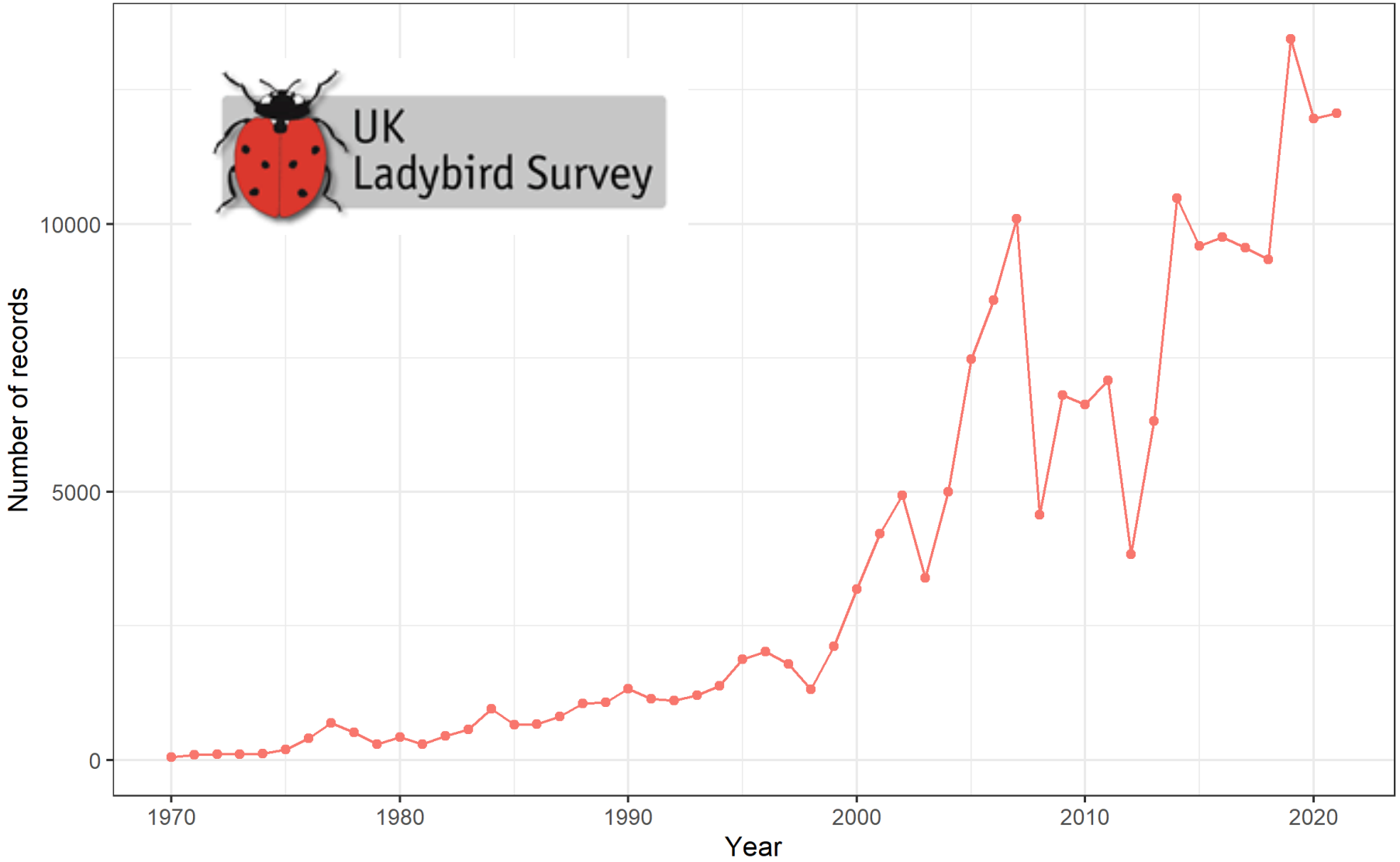
BRC Biological Records Centre



- Includes some structured recording data (EA, PoMS)

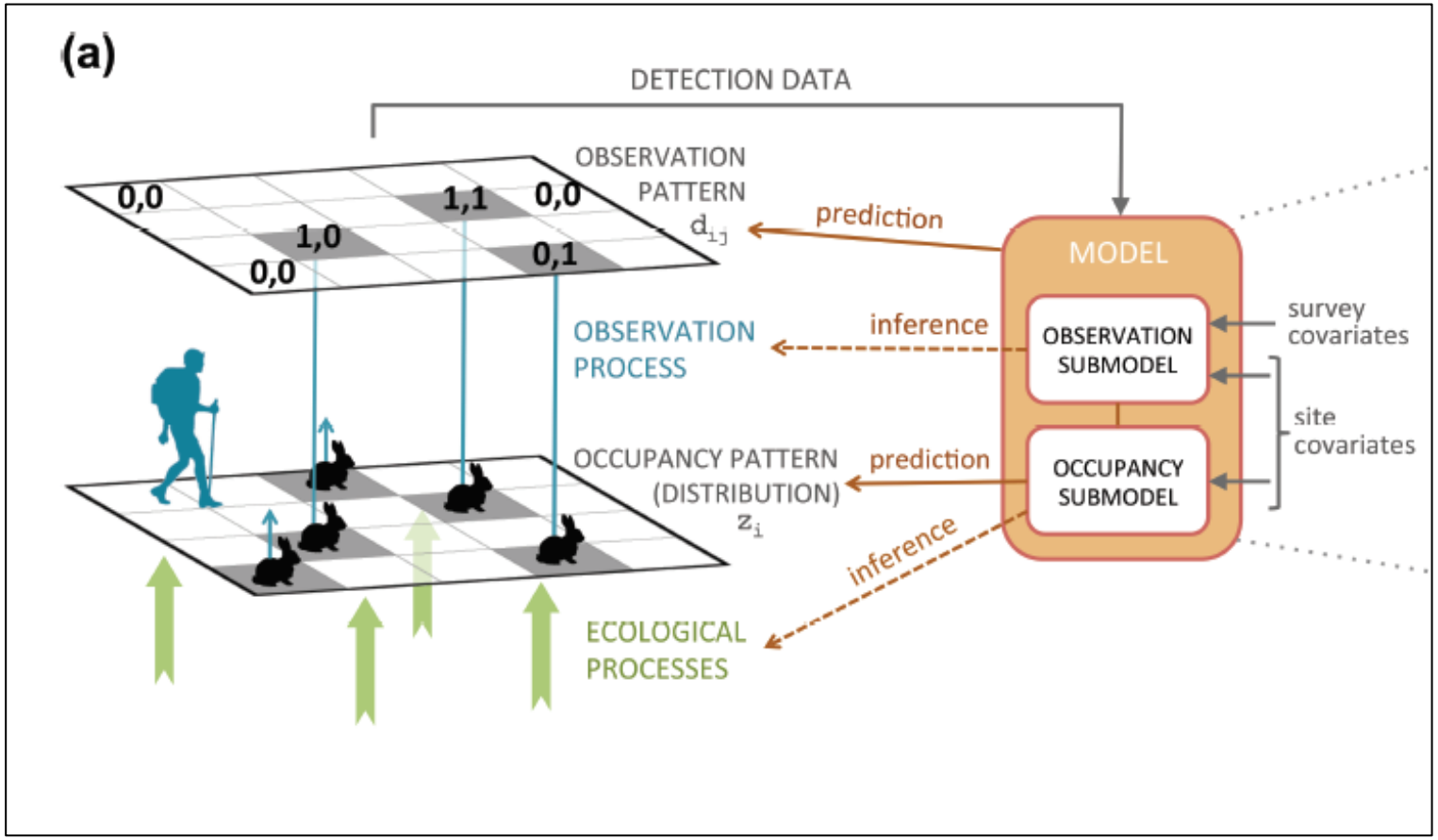
Data – issues for trend models

- Temporal increase in recording



Occupancy model runs

- Approximately 20 taxonomic groups
- Time frame: 1970 to ~2022
- 1 km grid cell scale
- 3585 species, of which trends were estimated for 1433 species



Guillera-Arroita et al (2016) Ecography

Risk-of-bias assessments (data driven)

- **All models and vulnerable to bias.**
- Key types of bias we tend to see are
    1) spatial (environmental) bias – temporal patterns
    2) taxonomic bias – temporal patterns

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ROBITT: A tool for assessing the risk-of-bias in studies of temporal trends in ecology

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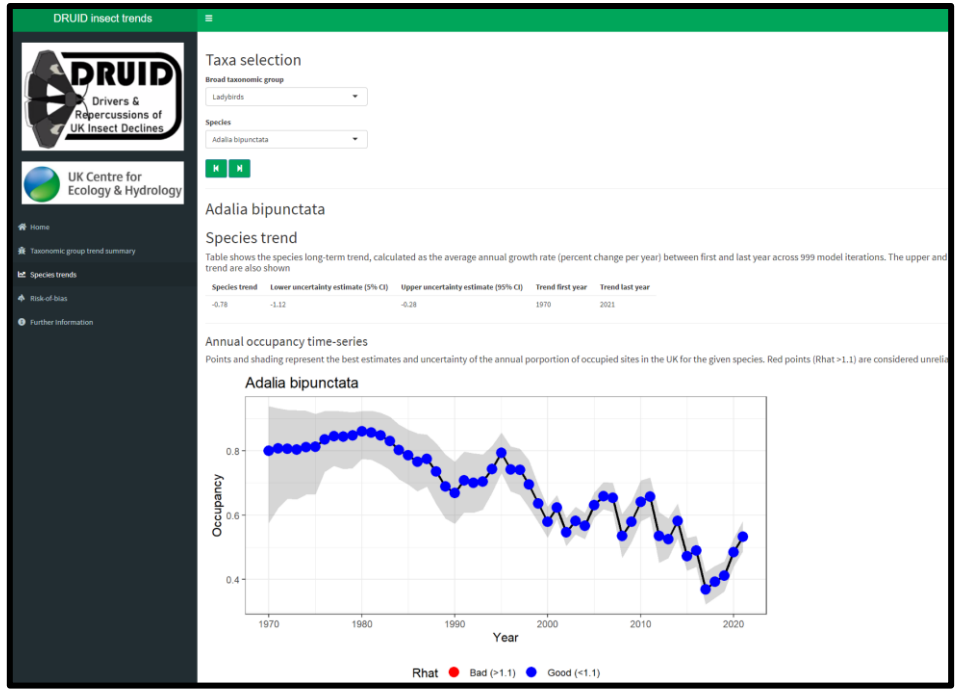
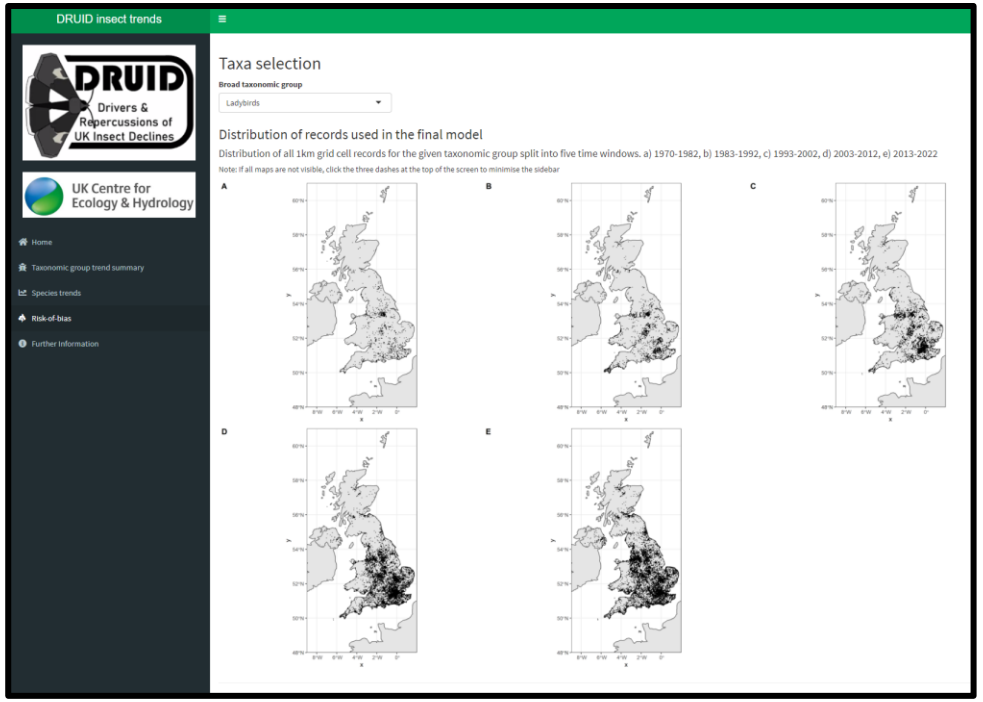
Section	Subsection	Question
(1) Pre-bias assessment	Define the inferential goal and population of interest	**What is the inferential goal (or goals) of your study, and what is the target population**
	Data provenance	**From where were your data acquired, and what are their key properties for your study?**
	Data processing (cleaning/manipulation)	**Please provide details and justification of all steps you have taken to clean the data described above.**
(2) Bias assessment	Assessment resolution	**At what spatial, temporal and taxonomic resolutions (grain sizes) will you conduct your bias assessment?**
	Geographic domain	**Are the data sampled from a representative portion of geographical space in the domain of interest?**
		Are your data sampled from the same portions of geographic space across time periods?
		If the answers to the above questions revealed any potential geographic biases, or temporal variation in geographic coverage, please explain, in detail, how you plan to mitigate them.
	Environmental domain	**Are your data sampled from a representative portion of environmental space in the domain of interest?**
		Are your data sampled from the same portion of environmental space across time periods?
		If the answers to the above questions revealed any potential environmental biases, or temporal variation in environmental coverage, please explain, in detail, how you plan to mitigate them.
	Taxonomic (phylogenetic/trait) domain	**Is the sampled portion of organismal (taxonomic/trait/phylogenetic; whichever is most relevant) space representative of the taxonomic/trait/phylogenetic domain of interest?**
		Do your data pertain to the same taxa/taxonomic domain across time periods?
		If the answers to the above questions revealed any potential taxonomic biases, or temporal variation in taxonomic coverage, please explain, in detail, how you plan to mitigate them.

Expert review

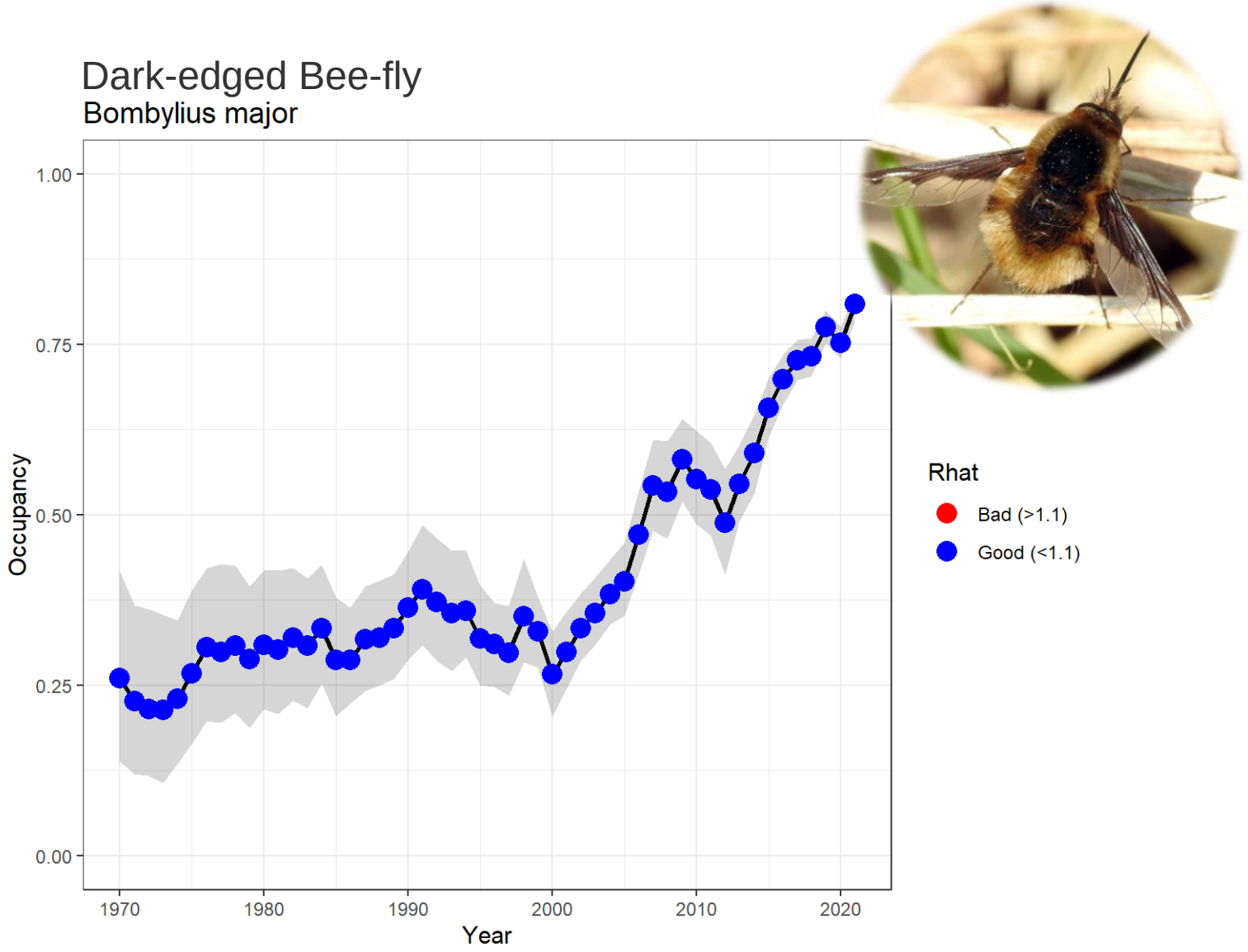
- Expert feedback process – two experts per group – 36 people (met 16)
- Score level of agreement with five statements about the reliability of the species and group level trends (via collaborative feedback form)
- Developed a shiny app to share the outputs with the schemes

https://gpowney.shinyapps.io/DRUID_trend_viewer/

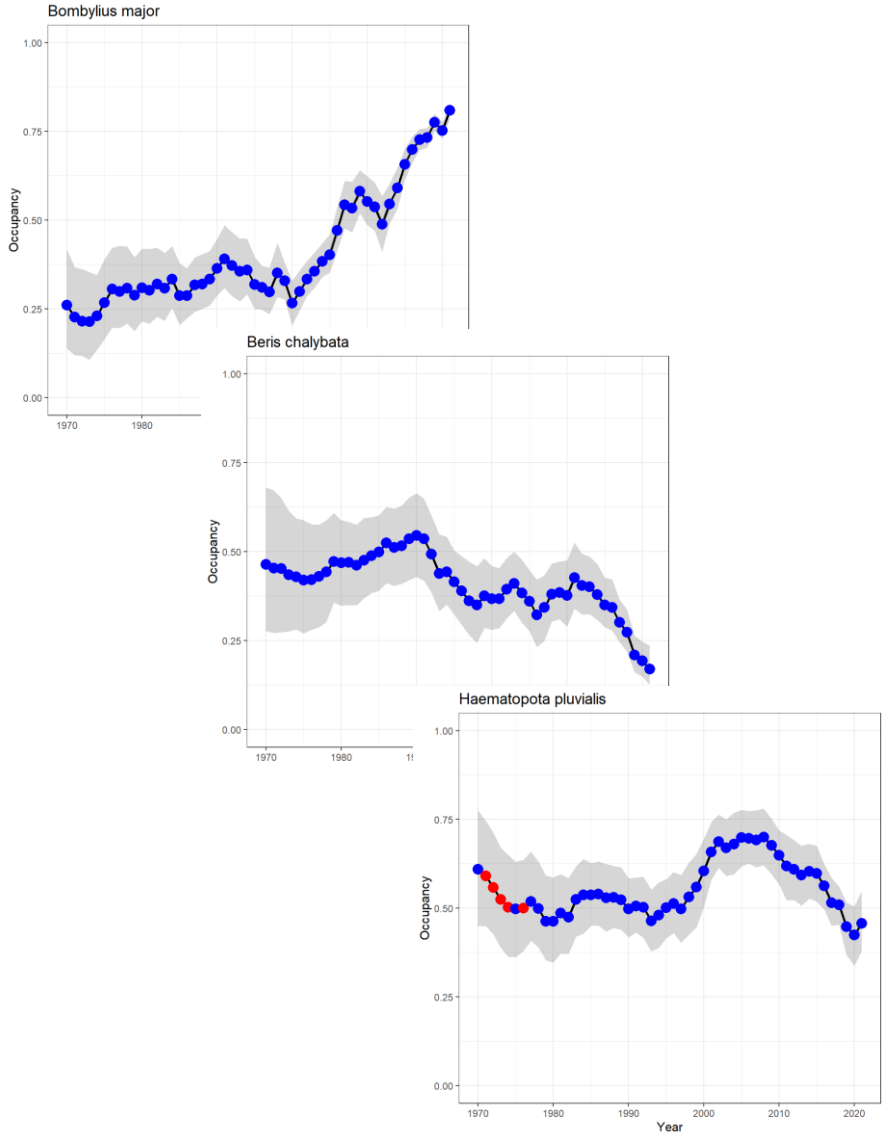


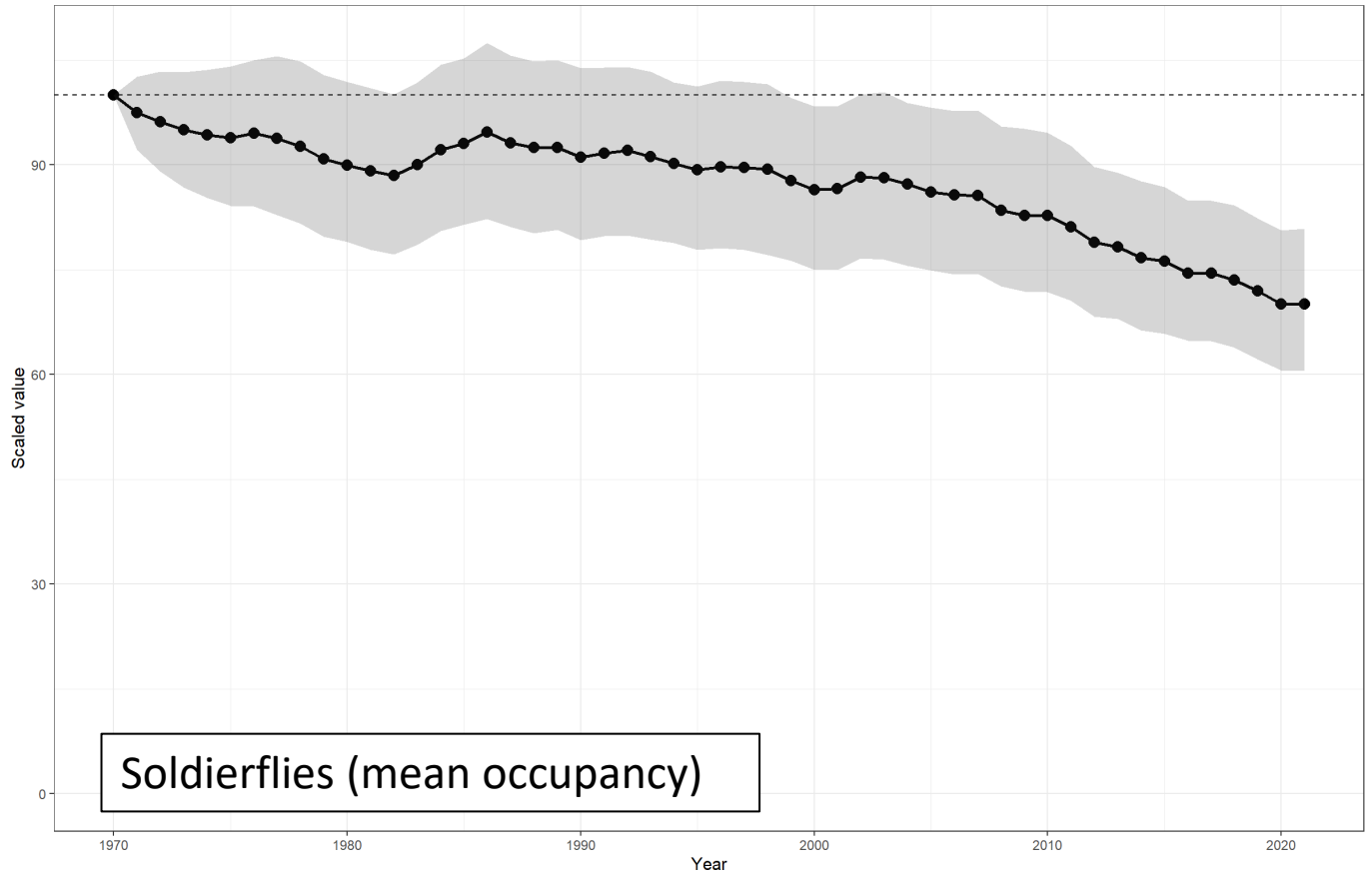


Results 1: Occupancy models - key output



Results 2: Average occupancy time-series

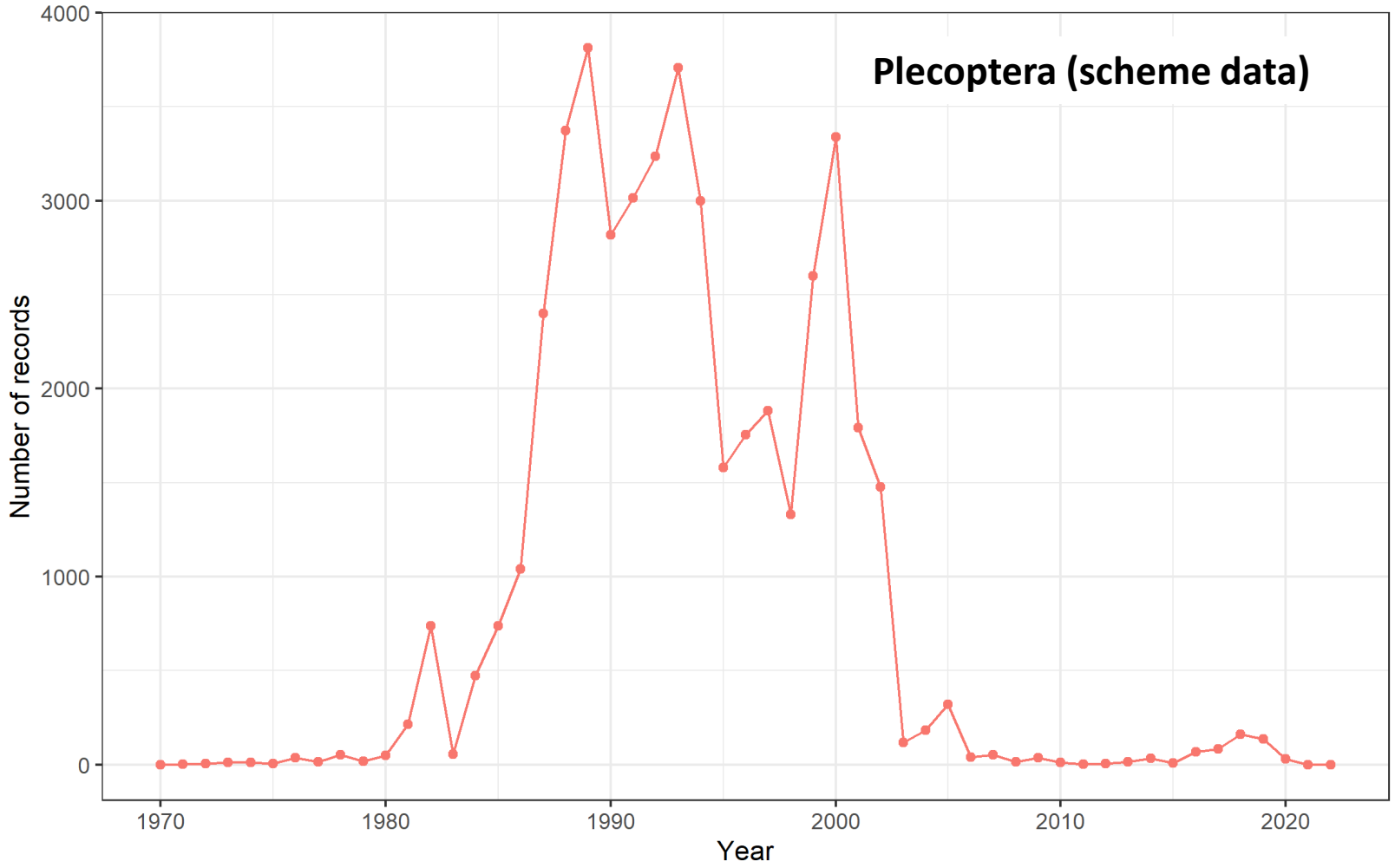




Result 3: Risk-of-bias I

riverfly recording schemes

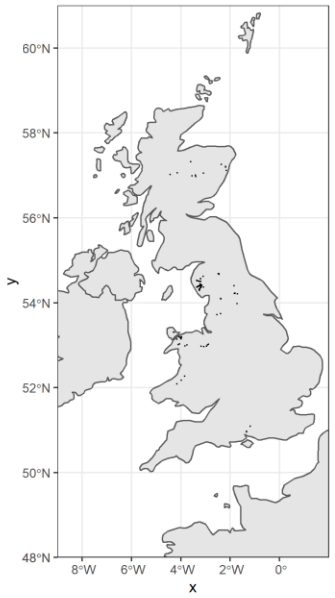
- Temporal variation in recorder effort is common



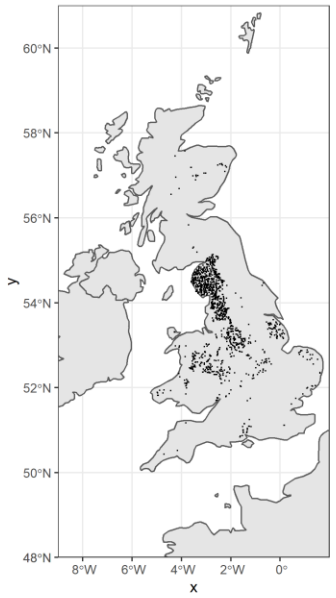
Result 4: Risk-of-bias II

Plecoptera (scheme data)

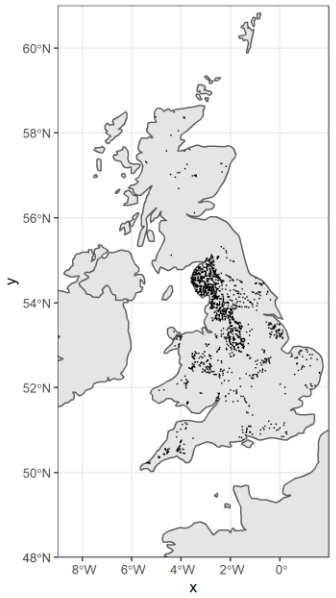
1970-82



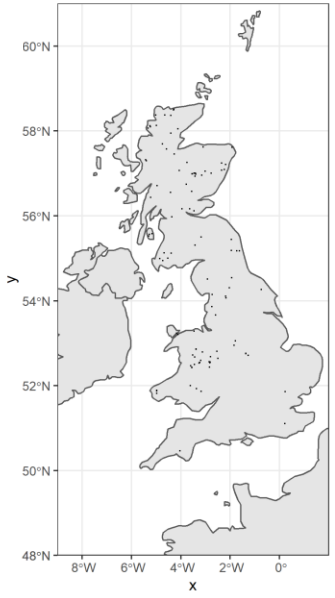
1983-92



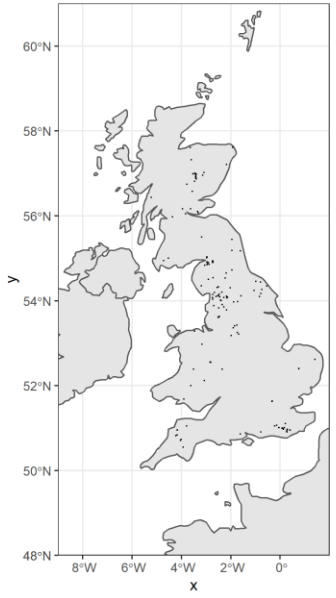
1993-02



2003-12

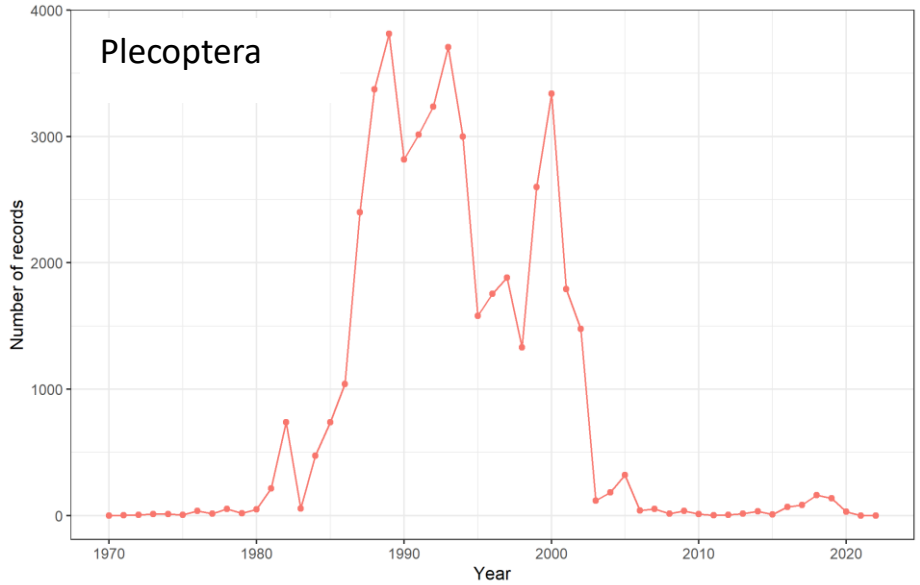


2013-22

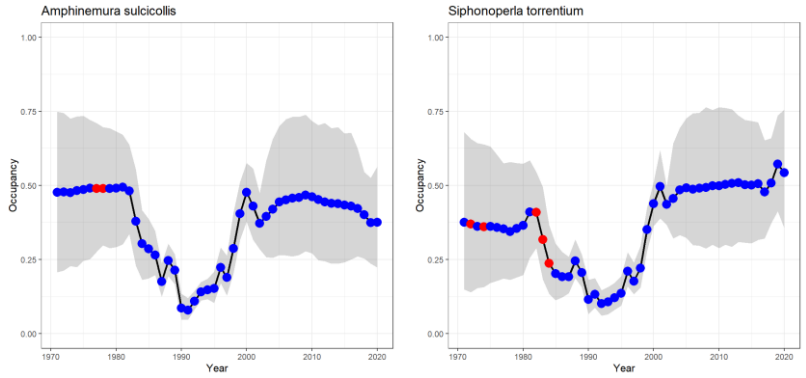


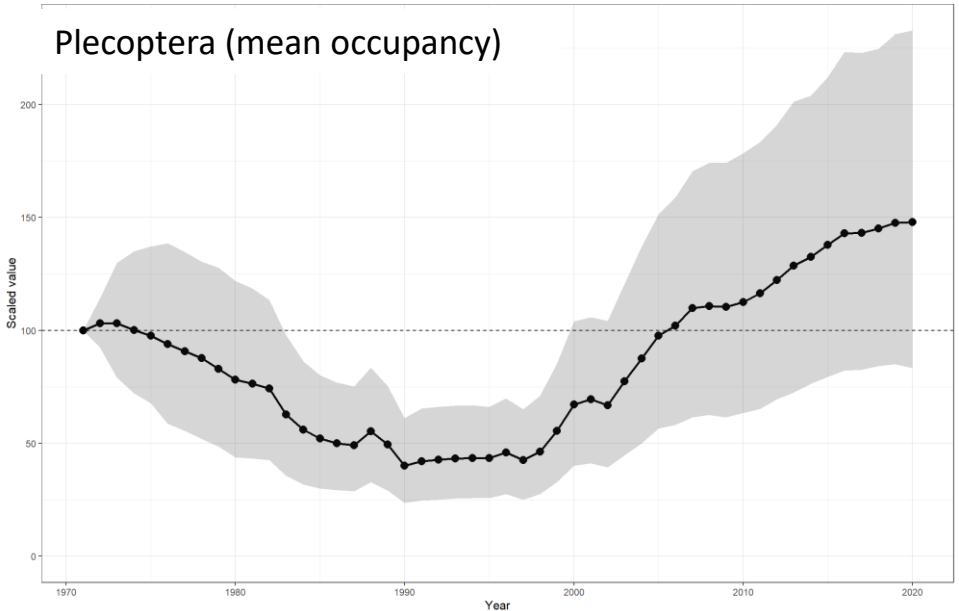
riverfly recording schemes

Results 5: Risk-of-bias assessment helps understanding



Can only assess trends in core period of recording. Restrict temporal inference of analysis.





Results 6: Risk-of-bias summary

Group	Bias Assessment					
	Spatial		Environmental		Taxonomic	
	Overall	Temporal	Overall	Temporal	Overall	Temporal
Ants	3	2	2	2	2	3
Bees	3	2	2	2	1	1
Wasps	3	2	2	2	2	1
Grasshoppers & crickets	3	2	2	2	3	3
Shieldbugs	2	3	2	3	2	3
Craneflies	3	3	3	3	2	2
Empid & dolichopodid flies	3	3	3	3	3	3
Fungus gnats	3	2	2	2	3	3
Soldierflies	2	3	2	3	2	3
Ground beetles	3	2	2	2	2	2
Ladybirds	2	2	2	2	1	3
Leaf & seed beetles	3	3	3	3	3	3
Longhorn beetles	2	2	2	2	3	3
Caddisflies	1	3	1	2	2	3
Mayflies	2	3	1	2	2	3
Stoneflies	3	3	3	3	2	3
Aquatic bugs	3	3	3	3	3	2
Dragonflies & damselflies	2	2	2	2	2	2

RISK SCORE
Minor (1)
Moderate (2)
Major (3)

Results 7: Expert feedback

1) The group level mean occupancy time-series accurately reflects known/expected average patterns of change for the given taxonomic group.

2) The species-specific occupancy time-series reliably reflect patterns of change for the species in question.

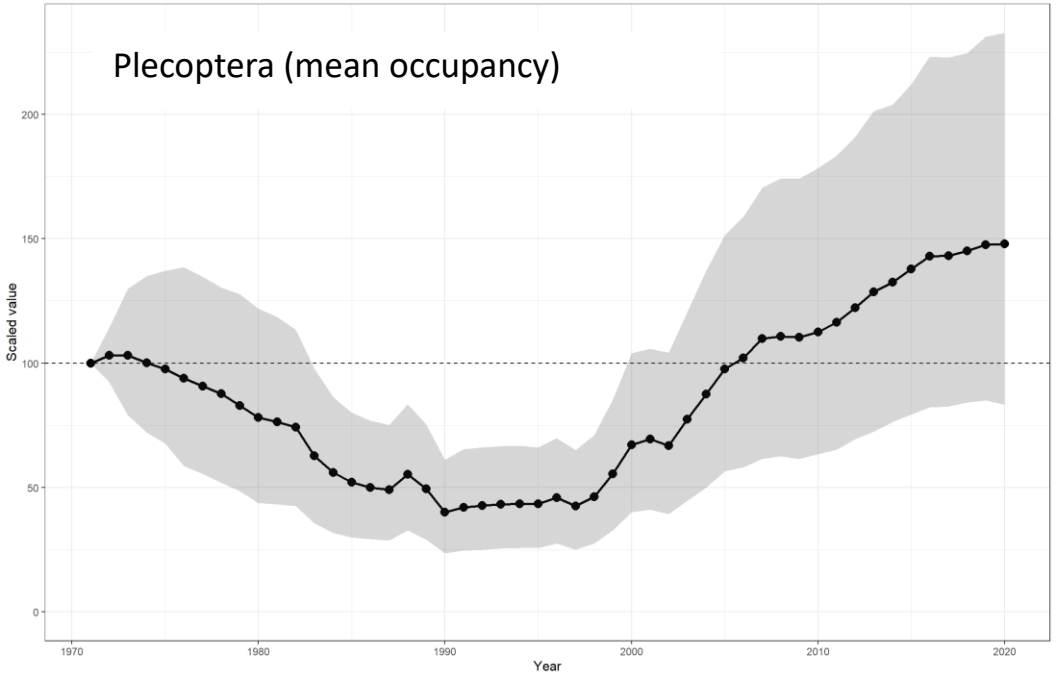
3) The species-specific long-term trend estimates accurately reflect known/expected trends for the given species.

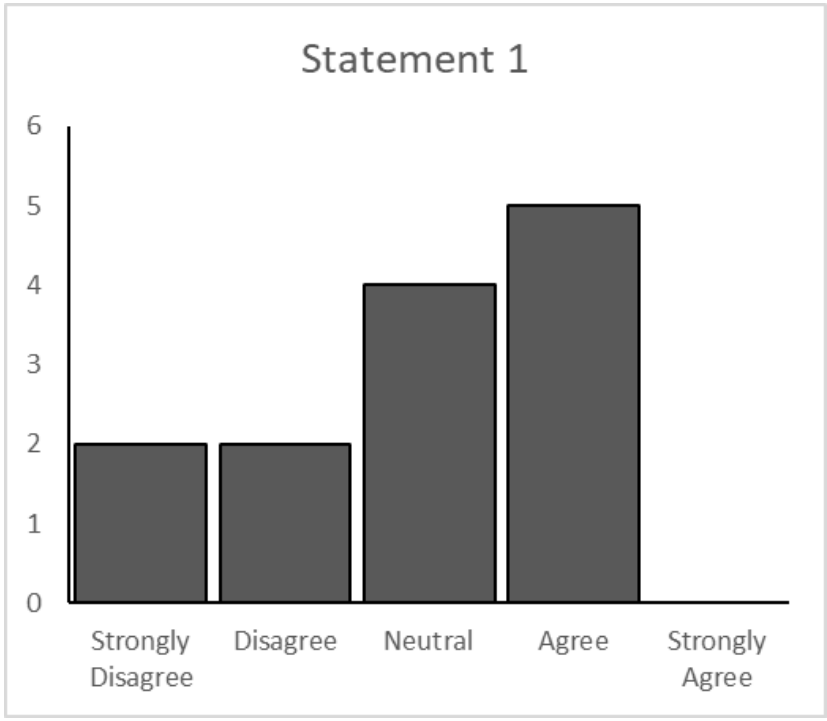
4) Inconsistent recording effort patterns over space and time are driving severe issues in the resulting species trends and annual occupancy plots.

5) The risk-of-bias tab reveal strong spatiotemporal recording patterns.

Results 8: Initial expert feedback summary (13 so far)

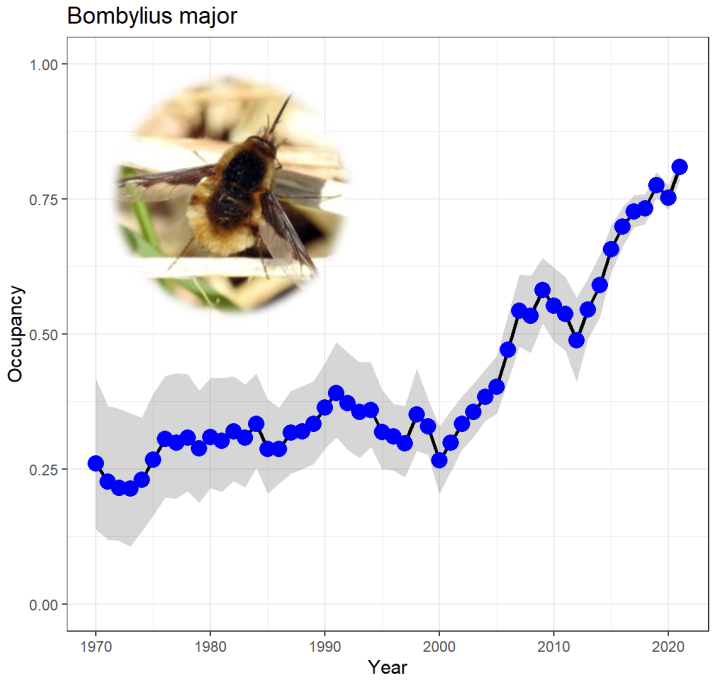
1. The group level mean occupancy time-series accurately reflects known/expected average patterns of change for the given taxonomic group.





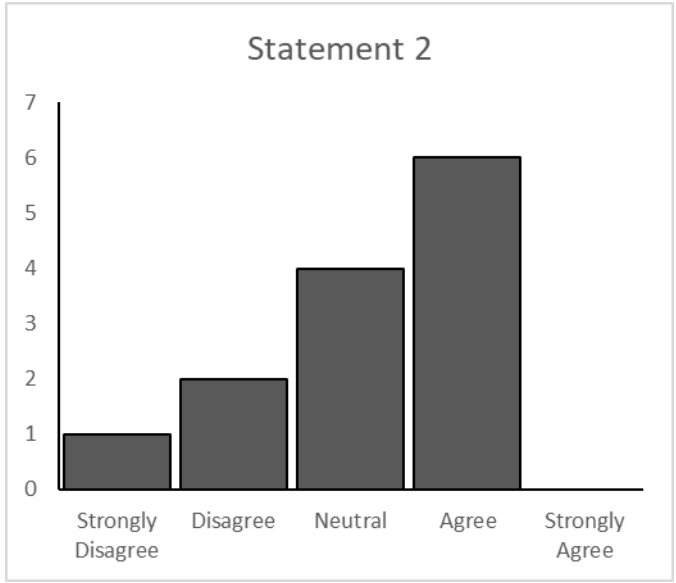
BALANCED

Results 9: Initial expert feedback summary



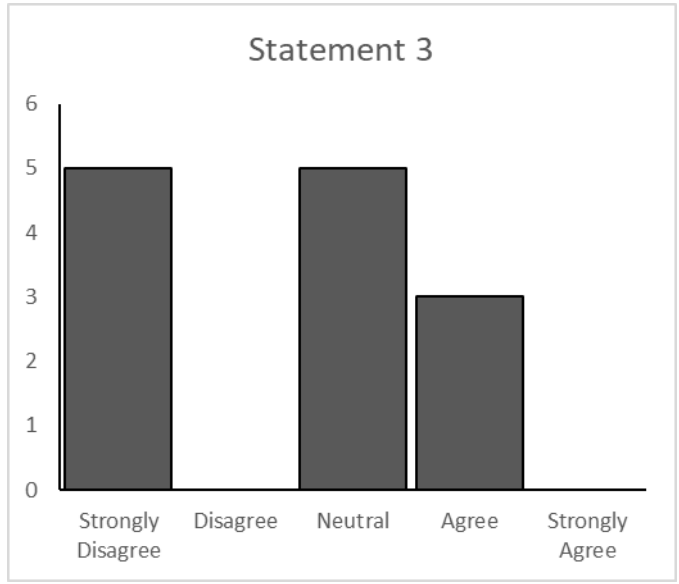
Annual growth rate 2.32%
(1.5% – 3.2%)

2. The species-specific occupancy time-series reliably reflect patterns of change for the species in question.



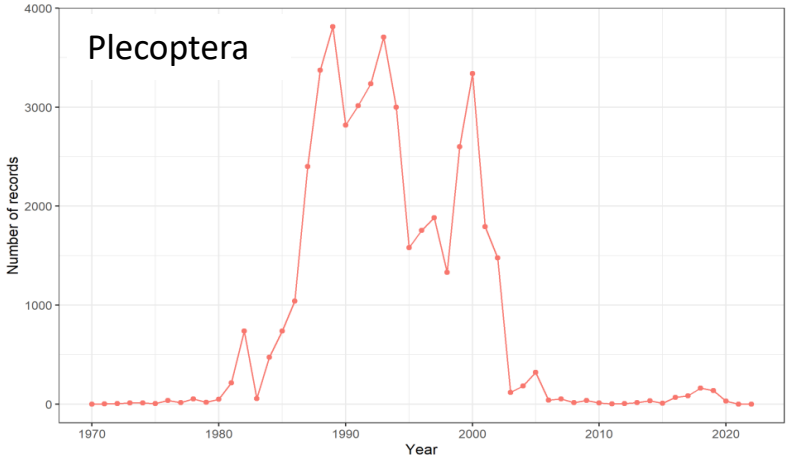
AGREE

3. The species-specific long-term trend estimates accurately reflect known/expected trends for the given species.

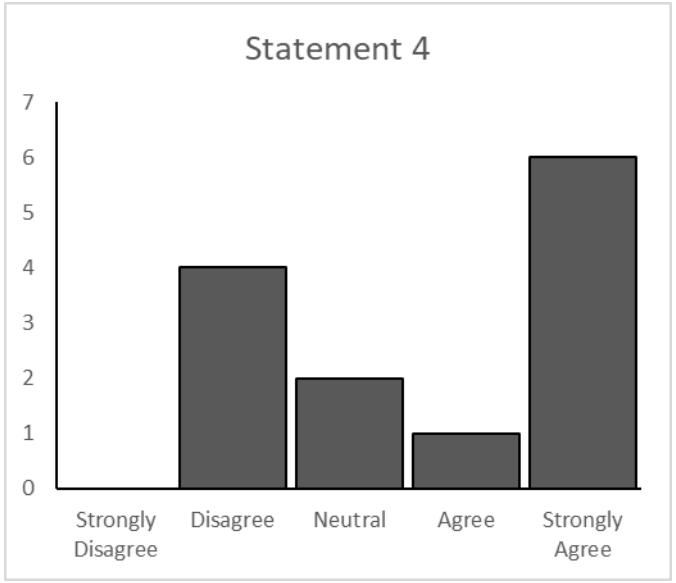


DISAGREE/NEUTRAL

Results 10: Initial expert feedback summary

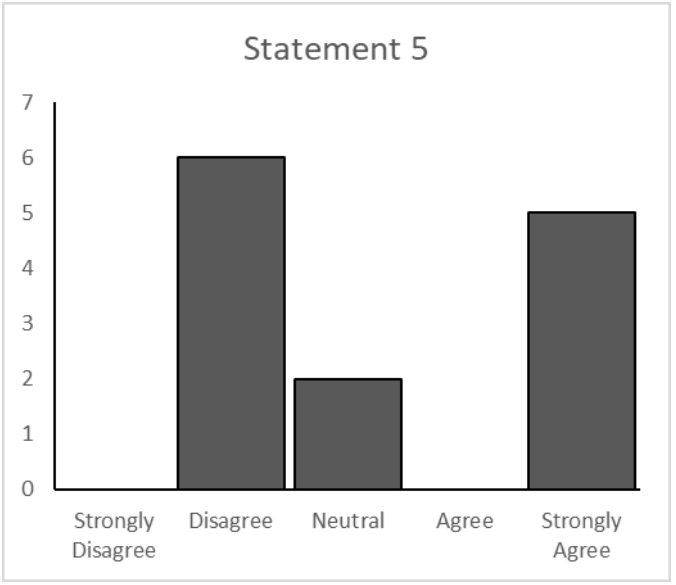


4. Inconsistent patterns of recording effort over space and time are driving severe issues in the resulting species trends and annual occupancy plots.



AGREE

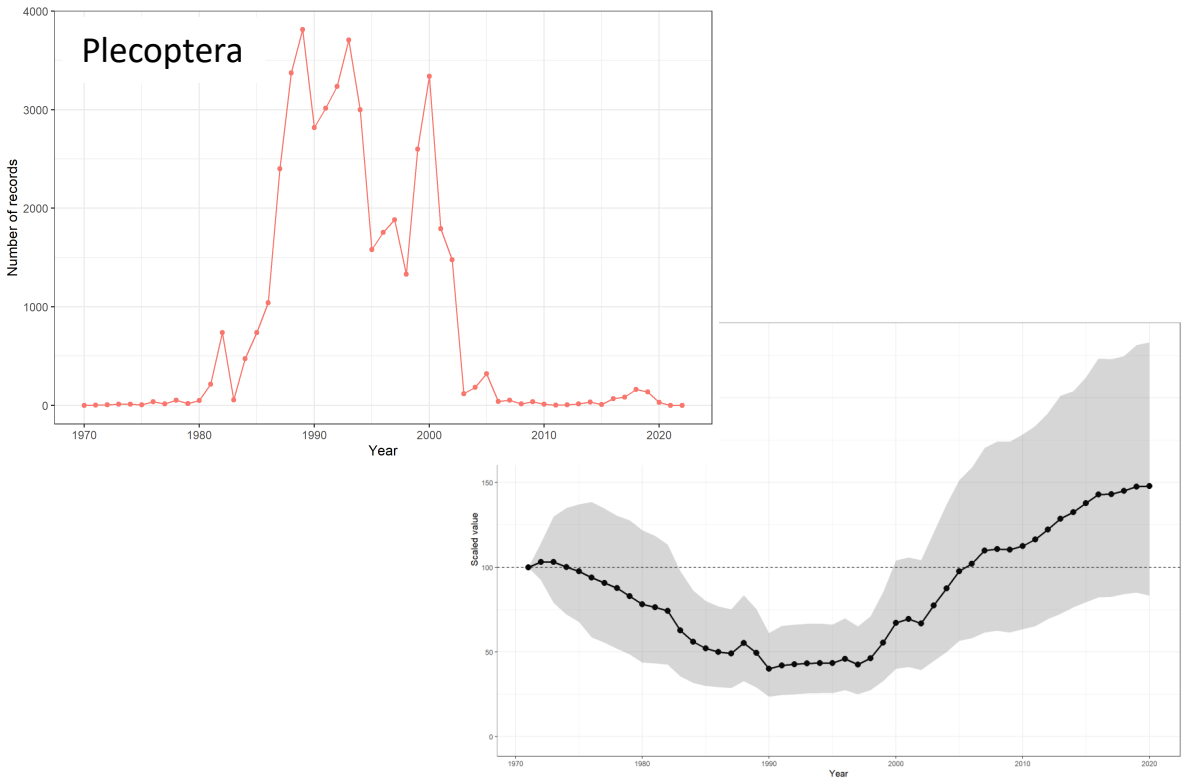
5. The risk-of-bias tab reveals strong spatiotemporal recording patterns.



BALANCED

Conclusion

- Risk-of-bias assessments reveal high levels of variation in the spatial, environmental and taxonomic coverage, and that this varies over time. Issue for occupancy models.



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Bees	3	2	2	2	1	1
Wasps	3	2	2	2	2	1
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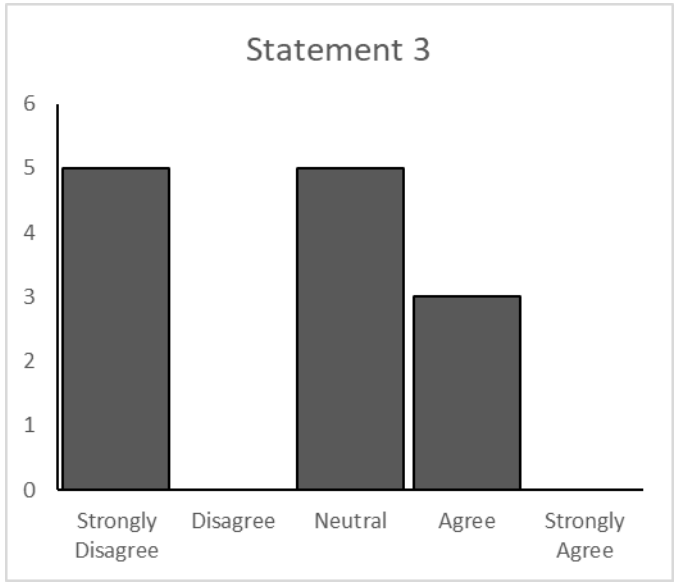
Shieldbugs	2	3	2	3	2	3
Craneflies	3	3	3	3	2	2
Empid & dolichopodid flies	3	3	3	3	3	3
Fungus gnats	3	2	2	2	3	3
Soldierflies	2	3	2	3	2	3
Ground beetles	3	2	2	2	2	2
Ladybirds	2	2	2	2	1	3
Leaf & seed beetles	3	3	3	3	3	3
Longhorn beetles	2	2	2	2	3	3
Caddisflies	1	3	1	2	2	3
Mayflies	2	3	1	2	2	3
Stoneflies	3	3	3	3	2	3
Aquatic bugs	3	3	3	3	3	2
Dragonflies & damselflies	2	2	2	2	2	2

Conclusion

- Experts (initial feedback):
  - Fairly balanced across levels of agreement.
  - Generally disagree with the species-specific trends and think trends may be biased.

3. The species-specific long-term trend estimates accurately reflect known/expected trends for the given species.



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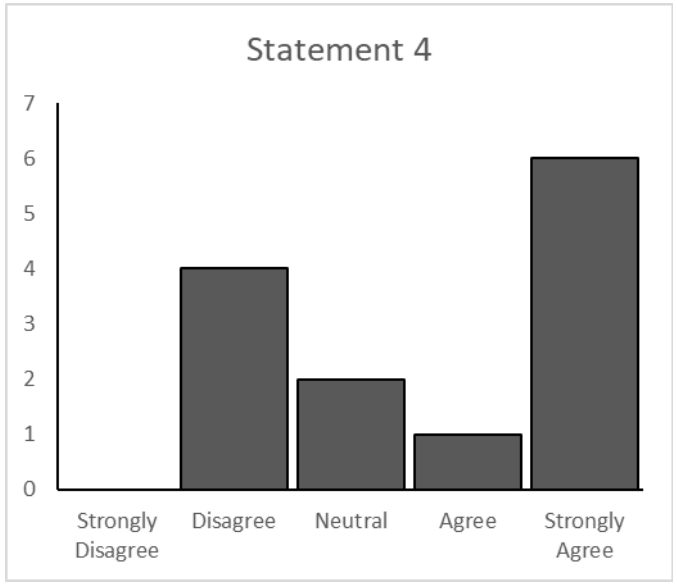
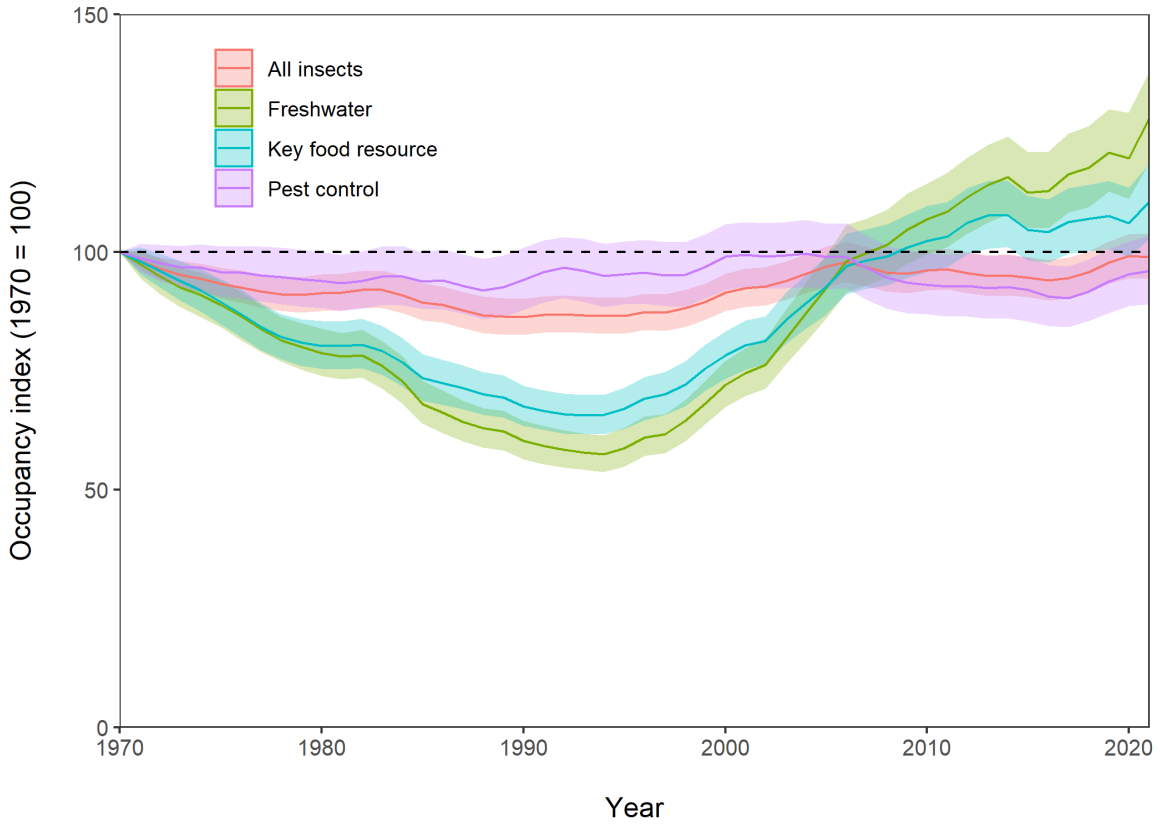


Conclusion

- Insects overall: stable. Note certain groups and species increasing and decreasing (as expected)



Acknowledgements

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Massive shout out to the scheme organisers and recorders without their efforts this would be a series of blank slides!

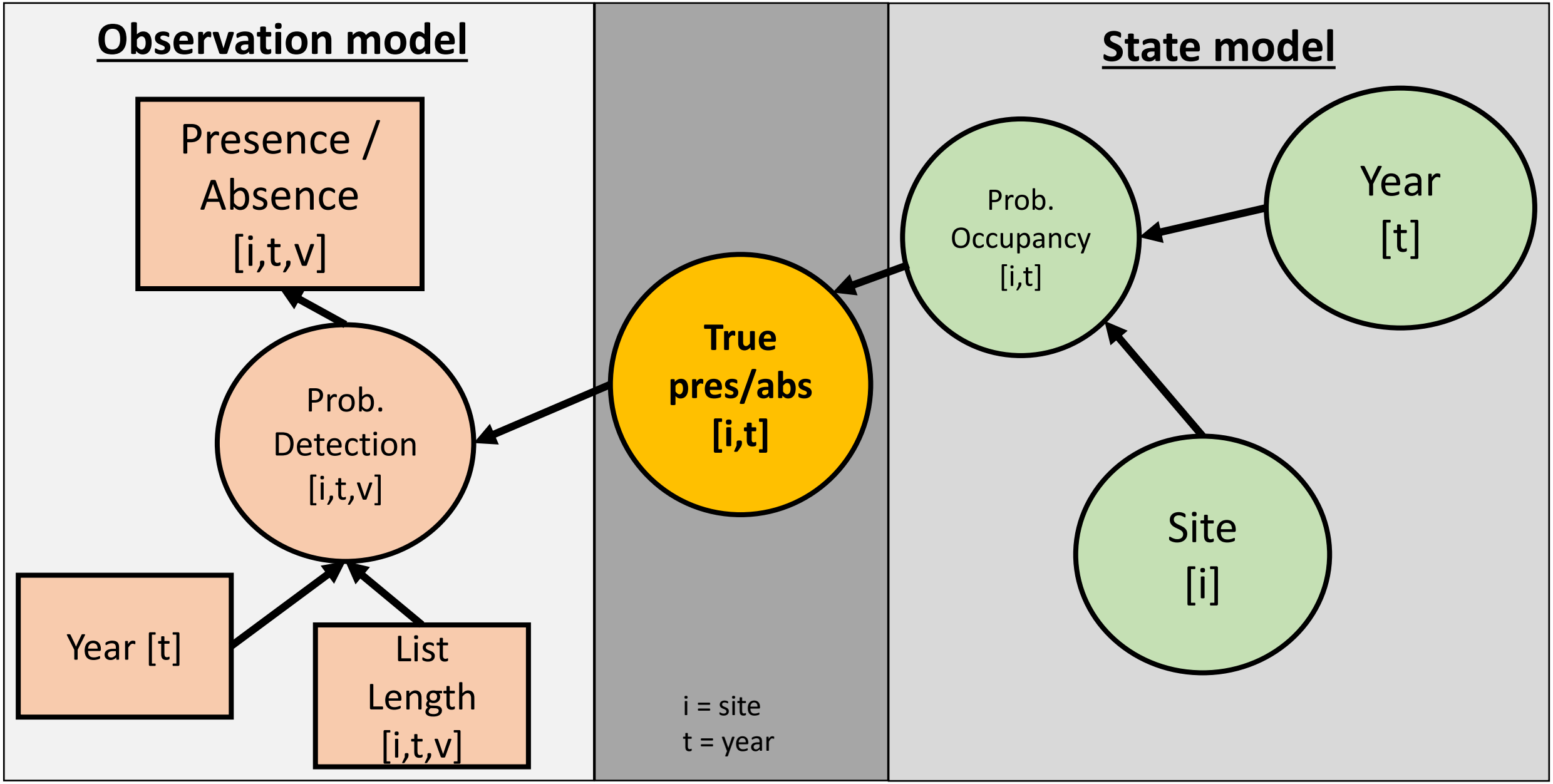
Key trend results

Group	Notable increase (%)	Notable decrease (%)	Average trend
All insects	18.20%	17.70%	stable
Freshwater	-	-	increase
Key food resource	-	-	increase
Pest control	-	-	stable
Ants	13.9	19.4	stable
Bees	23.6	24.1	stable
Wasps	15.8	29.1	decrease
Grasshoppers & crickets	12.0	32.0	stable
Shieldbugs	32.6	28.3	stable
Craneflies	10.0	23.8	decrease
Empid & dolichopodid flies	19.8	11.9	increase
Fungus gnats	13.3	13.3	stable
Soldierflies	10.5	31.6	decrease
Ground beetles	8.3	6.6	stable
Ladybirds	32.5	27.5	increase
Leaf & seed beetles	15.6	11.9	stable
Longhorn beetles	26.9	7.7	stable
Caddisflies	19.0	5.0	stable
Mayflies	30.8	20.5	stable
Stoneflies	33.3	11.1	stable
Aquatic bugs	12.1	3.0	stable
Dragonflies & damselflies	42.9	16.7	increase

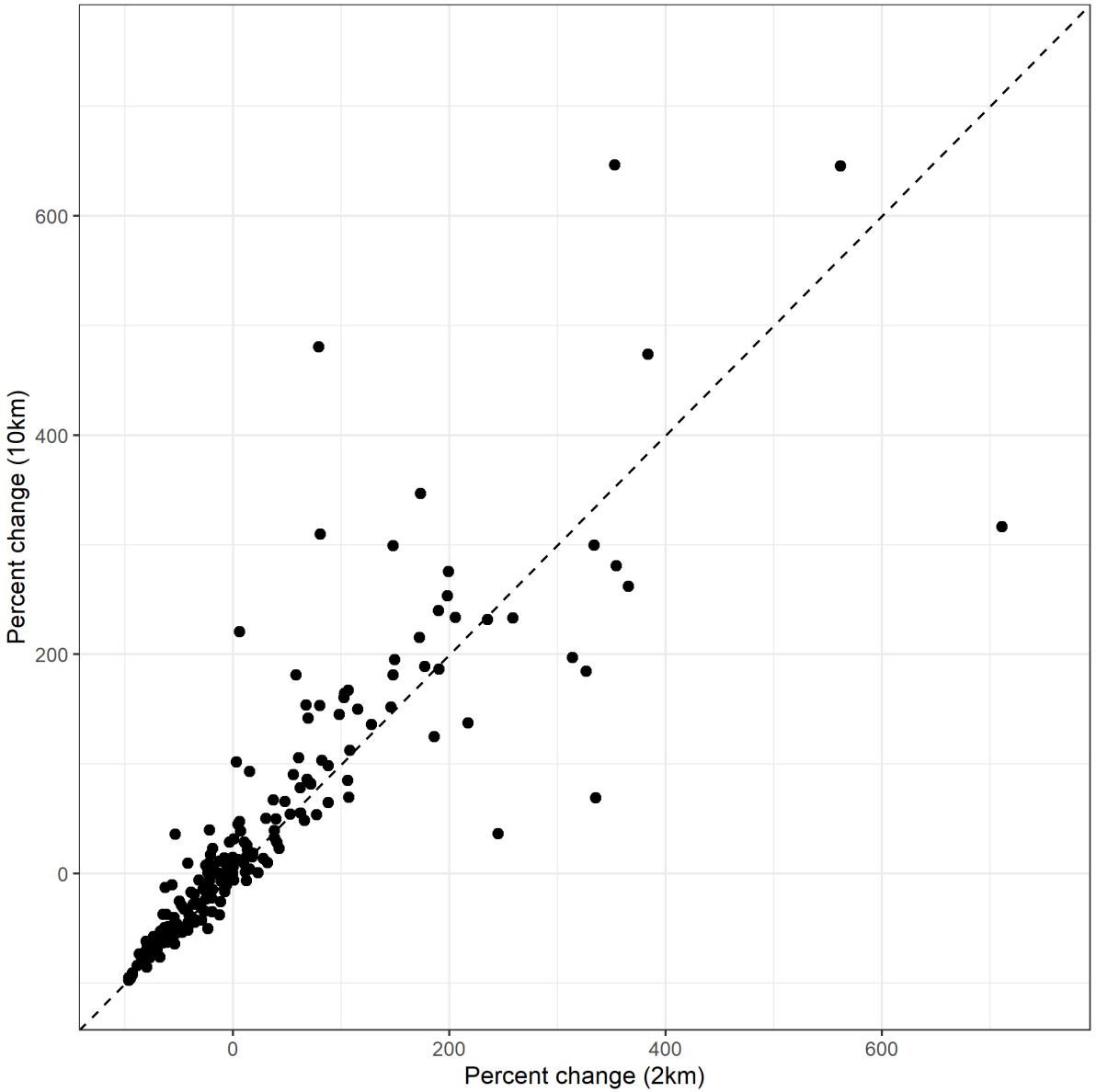
Risk-of-bias summary – ranking system

Potential driver of bias based on the current model framework	Risk score
Are data representative of geographical space of inference?	
Major: Clear evidence that the spatial pattern of the survey data does not reflect the broad distribution pattern of the taxonomic group	3
Moderate: Clear spatial pattern in the survey data, but unclear if this reflects the broad distribution of the taxonomic group (no evidence)	2
Minor: The spatial pattern of recording matches the broad distribution of the taxonomic group. The data reflect a simple random sample, where sites within the groups range have an equal chance of selection.	1
Is the spatial pattern of recording consistent over time?	
Major: Clear evidence of temporal variation in the spatial pattern of recording. This is reflected in large areas of the study region being under-recorded in different time periods.	3
Moderate: Evidence of a change in the spatial pattern of recording, but the broad spatial pattern of recording is consistent.	2
Minor: Evidence suggests the spatial pattern of recording is consistent over time	1

Original Sparta occupancy model



Trend comparison – occupancy spatial



- Generally positively correlated
- Study examined this showing similar trend results regardless of spatial scale (1, 2, 5, 10km)
- Caveat: based on 1km data only scaled up.

JÖNSSON et al. (2021) Insect Conservation & Diversity **14**, 543–555